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(54) IMPROVEMENTS IN OR RELATING TO TRANSFORMER CORES

(71) We, ROSS & CATHERALL LIMITED, (formerly Marrison & Catherall Limited), a British Company, of Forge Lane, Killamarsh, near Sheffield, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to transformer cores and is particularly concerned with the type of core that is produced by winding a continuous strip of metal on a mandrel until the desired thickness of the core has been attained.

As conventionally produced, the strip wound on the mandrel is first pressed to the required core shape, and as the material of the strip is of the type that is highly susceptible to strain hardening e.g., grain-oriented silicon iron, it is strain hardened by the winding onto the mandrel and the forming to shape. This strain hardening seriously affects the magnetic and electrical properties of the core and has the result that an increased magnetising force is required to reach a given level of magnetisation as compared with what would be required for the material in the unstrained state. The core is therefore annealed to relieve the strain hardening that has taken place, and thus remove this cause of serious losses of electrical properties. Following this, the loose winding is bonded into a "solid" body by impregnating the winding with a hardenable resinous material. Bonding is necessary for rigidity, but it reintroduces mechanical strain, and it is essential for this impregnation step to be carefully controlled to minimise degradation of the performance of the core. No matter how carefully the impregnation step is controlled, it is impossible to avoid completely the setting up of mechanical strain with resultant spoiling of electrical properties, but hitherto, this has been accepted because of the need for a rigid structure. The strain due to bonding is relieved, though not entirely eliminated by severing the core into two core halves for the purpose of enabling the windings for the core to be easily applied. However, this severing has the disadvantage of introducing an air gap between the core halves, and to limit the adverse effect this has on the performance of the core, the cut faces must be carefully ground and lapped, another reason why the core must be a rigid structure.

The object of the present invention is the provision of a rigid core in which strains and consequent losses of electrical properties are reduced to a minimum.

According to the present invention, a transformer core free from internal bonding means, is formed by winding and forming strip material into the shape of the core, the whole core having an external coating of a hardened synthetic plastics material, the coating having sufficient strength to prevent relative movement of adjacent turns of the strip material. Thus, no bonding material is required between adjacent turns of the strip material, and therefore no mechanical straining of the core is reintroduced after the strain due to winding and forming has been relieved by annealing, yet the core is sufficiently strong to prevent relative movement of adjacent turns of the strip material, particularly during the cutting of the core and the subsequent grinding and lapping of the cut faces, and also during use.

The synthetic plastics coating may be an epoxy resin and may be applied by any means suitable to provide the whole core with a uniform thickness of the coating such as by a fluidised bed or electrostatic spraying means, by dipping or by moulding in a die. The coating of hardened synthetic plastics material may also serve as an insulating coating for the core. Thus, a toroidal electrical winding may be applied directly to the coated core, or, alternatively, when used in place of cut cores which hitherto have not been insulated, the coating has the advantage that the level of insulation re-

quired for the preformed windings may be reduced.

Alternatively, the coating may be glass fibre reinforced synthetic plastics material securely bonded to the laminations. Thus prior to cutting the core, it may be strapped with glass fibre reinforced synthetic plastics material at the point of cutting.

A preferred embodiment of the invention will now be described with reference to the accompanying drawing, which is a perspective view of a transformer core of the 'C' type.

A transformer core 1, formed by winding strip material 2 on to a mandrel (not shown) and subsequently formed to the shape of the core, has a uniform coating 3 of a hardenable synthetic plastics material applied to its external surfaces after the core has been annealed to relieve the strain hardening produced by the winding and forming. The strain due to this external bonding is then partially relieved when the core 1 is severed into two core halves 4 and 5, having cut faces 6 and 7 respectively to enable the easy application of core windings. However, the severing results in an air gap being introduced between the core halves 4 and 5, when these are assembled in a transformer, this having an adverse effect on the performance of the core. To minimise this disadvantage, the cut faces 6 and 7 must be carefully ground and lapped, to reduce the air gap to a minimum, prior to assembly, which is one reason why the core must be a rigid structure.

By eliminating the conventional internal bond, and thus the strain that this introduces, the electrical properties of the core are improved as is shown by the following comparison between four styles of rectangular C-type transformer cores made from 3.1/2% grain oriented silicon iron magnetised to peak flux density of 1.7 Wb/m^2 at 50Hz when impregnated with epoxy resin, cured and cut, and when coated with epoxy reson to a thickness of 0.20" by the fluidised bed technique and cut. Twenty cores of each style were tested for each of the two conditions.

Style of Core	HWR40/ 16/13	HWR10/ 8/13	HWR50/ 24/13	HWR70/ 18/13
a) *Impregnated:* range of magnetising volt amperes.	1.39 to 2.60	0.785 to 1.42	5.00 to 6.78	6.1 to 8.0
average magnetising volt amperes	1.77	1.14	6.0	6.85
b) *Externally coated:* range of magnetising volt amperes.	1.39 to 1.82	0.785 to 1.000	4.95 to 6.46	5.50 to 7.50
average magnetising volt amperes	1.61	0.885	6.0	6.3

Further tests using the above conditions, but on cores of 0.004" thick strip material at a peak flux density of 1.5 Wb/m^2 and a frequency of 400 Hz produced the following results.

Style of Core: HWR 10/12/4	
a) *Impregnated*	
range of magnetising volt amperes	5.05 to 8.68
average magnetising volt amperes	6.78
b) *Externally coated*	
range of magnetising volt amperes	4.52 to 7.40
average magnetising volt amperes	6.00

WHAT WE CLAIM IS:—

1. A transformer core free from internal bonding means, formed by winding and forming strip material into the shape of the core, the whole core having an external coating of a hardened synthetic plastics material, the coating having sufficient strength to prevent relative movement of adjacent turns of the strip material.

2. A core as in Claim 1, wherein the synthetic plastics coating is an epoxy resin.

3. A core as in Claim 1, wherein the synthetic plastics coating is glass fibre reinforced synthetic plastics material securely bonded to the laminations.

4. A core as in Claims 1 to 3, wherein the synthetic plastics coating is applied by any means suitable to provide the whole

core with a uniform thickness of the coating.

5. A core as in any of Claims 1 to 4, wherein the coating of hardened synthetic plastics material serves as an insulating coating for the core.

6. A core substantially as hereinbefore described with reference to the accompanying drawing.

7. A method of producing a transformer core substantially as hereinbefore described with reference to the accompanying drawing.

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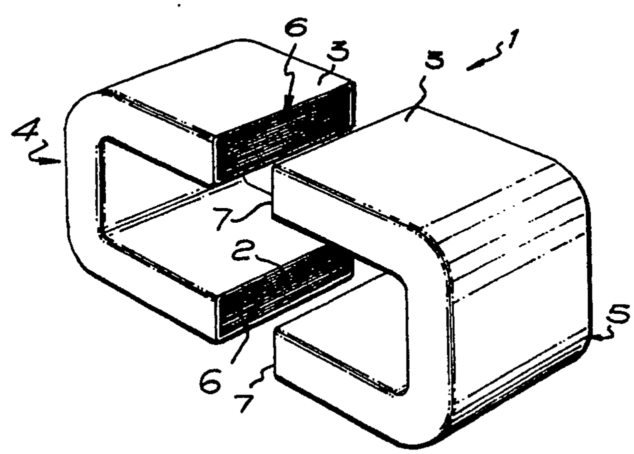
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